

SOLAR OBSERVATIONS

SOLAR RADIATION MEASUREMENTS DURING
MARCH 1936

By IRVING F. HAND, Assistant in Solar Radiation Investigations

For a description of instruments employed and their exposures, the reader is referred to the January 1935 REVIEW, page 24.

Table 1 shows that solar radiation intensities averaged close to normal at all three Weather Bureau stations.

Table 2 shows a deficiency in the amount of total solar and sky radiation at all stations with the exception of Chicago, New York, Fresno, Twin Falls, and Riverside.

Polarization measurements made at Washington during March averaged 59.8 percent, with a maximum of 61 percent on the 20th. These are close to normal for the month. No observations were obtained at Madison because of snow and ice cover.

TABLE 1.—*Solar radiation intensities during March 1936*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance										Local mean solar time
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	
	75th mer. time	Air mass									
e	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e	
Mar. 3	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm	6.20
Mar. 4	4.37	—	—	—	—	—	—	—	—	—	2.16
Mar. 5	2.37	—	—	—	—	—	—	—	—	—	3.30
Mar. 6	3.63	0.90	1.02	1.17	1.41	1.46	1.66	—	—	—	5.36
Mar. 7	3.81	.91	1.03	1.22	1.37	—	—	—	—	—	—
Mar. 9	4.17	—	—	—	—	—	—	—	—	—	7.04
Mar. 12	3.00	—	—	1.22	1.32	1.51	1.63	1.43	1.31	1.16	2.62
Mar. 13	2.87	—	—	—	—	—	—	—	—	—	3.30
Mar. 16	4.17	—	—	—	—	—	—	—	—	—	3.00
Mar. 17	4.17	.87	.98	1.05	—	—	—	—	—	—	4.17
Mar. 18	3.45	—	—	—	—	—	—	—	—	—	3.45
Mar. 19	4.57	—	—	—	—	—	—	—	—	—	2.26
Mar. 20	3.00	.78	.96	1.06	1.33	—	—	—	—	—	2.87
Mar. 21	3.30	.91	—	—	—	—	—	—	—	—	3.81
Mar. 24	3.30	.89	1.01	1.20	1.40	1.66	1.33	1.10	.94	.81	2.49
Mar. 25	2.62	—	—	—	—	—	—	.99	.69	.42	2.74
Mar. 27	2.26	—	—	—	—	—	—	1.33	1.16	1.00	.88
Mar. 30	3.00	—	—	—	—	—	—	1.10	1.00	—	—
Means	—	—	—	—	—	—	—	—	—	—	—
Departures	+.88	1.03	1.16	1.38	1.63	1.26	1.06	.91	.74	—	—
	+.04	+.09	+.07	+.10	+.10	-.01	-.03	-.03	-.07	—	—

MADISON, WIS.

Date	Sun's zenith distance										Local mean solar time
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	
	75th mer. time	Air mass									
e	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e	
Mar. 6	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm	2.62
Mar. 20	5.16	0.63	0.82	1.08	—	—	—	—	—	2.62	4.4
Mar. 30	4.75	0.93	1.12	1.29	1.41	—	—	—	—	4.17	2.4
Means	6.50	—	—	.66	.86	—	—	—	—	—	2.4
Departures	—	(.93)	(.88)	.92	1.12	—	—	—	—	—	—
	+.20	+.07	-.03	-.03	—	—	—	—	—	—	—

Date	Sun's zenith distance										Local mean solar time
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	
	75th mer. time	Air mass									
e	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e	
Mar. 3	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm	6.20
Mar. 4	2.87	—	—	—	—	—	—	—	—	—	2.8
Mar. 17	3.30	0.63	0.81	1.00	1.23	—	—	—	—	—	4.4
Mar. 18	2.87	.77	.95	1.09	1.30	1.54	—	—	—	—	3.6
Mar. 25	3.00	.82	.92	—	1.28	1.56	—	—	—	—	3.5
Mar. 27	3.45	—	—	—	—	1.48	—	—	—	—	4.6
Mar. 28	3.99	—	—	—	—	—	—	—	—	—	7.6
Mar. 31	1.96	—	1.02	1.16	1.32	—	—	—	—	—	7.6
Means	—	.76	.91	1.08	1.30	1.54	—	—	—	—	—
Departures	—	.16	-.11	-.08	-.01	-.04	—	—	—	—	—

Date	Sun's zenith distance										Local mean solar time
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	
	75th mer. time	Air mass									
e	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e	
Mar. 3	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm	6.20
Mar. 4	2.87	—	—	—	—	—	—	—	—	—	2.8
Mar. 17	3.30	0.63	0.81	1.00	1.23	—	—	—	—	—	4.4
Mar. 18	2.87	.77	.95	1.09	1.30	1.54	—	—	—	—	3.6
Mar. 25	3.00	.82	.92	—	1.28	1.56	—	—	—	—	3.5
Mar. 27	3.45	—	—	—	—	1.48	—	—	—	—	4.6
Mar. 28	3.99	—	—	—	—	—	—	—	—	—	7.6
Mar. 31	1.96	—	1.02	1.16	1.32	—	—	—	—	—	7.6
Means	—	.76	.91	1.08	1.30	1.54	—	—	—	—	—
Departures	—	.16	-.11	-.08	-.01	-.04	—	—	—	—	—

Date	Sun's zenith distance										Local mean solar time
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	
	75th mer. time	Air mass									
e	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e	
Mar. 3	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm	6.20
Mar. 4	2.87	—	—	—	—	—	—	—	—	—	2.8
Mar. 17	3.30	0.63	0.81	1.00	1.23	—	—	—	—	—	4.4
Mar. 18	2.87	.77	.95	1.09	1.30	1.54	—	—	—	—	3.6
Mar. 25	3.00	.82	.92	—	1.28	1.56	—	—	—	—	3.5
Mar. 27	3.45	—	—	—	—	1.48	—	—	—	—	4.6
Mar. 28	3.99	—	—	—	—	—	—	—	—	—	7.6
Mar. 31	1.96	—	1.02	1.16	1.32	—	—	—	—	—	7.6
Means	—	.76	.91	1.08	1.30	1.54	—	—	—	—	—
Departures	—	.16	-.11	-.08	-.01	-.04	—	—	—	—	—

Date	Sun's zenith distance										Local mean solar time
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	
	75th mer. time	Air mass									
e	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e	
Mar. 3	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm	6.20
Mar. 4	2.87	—	—	—	—	—	—	—	—	—	2.8
Mar. 17	3.30	0.63	0.81	1.00	1.23	—	—	—	—	—	4.4
Mar. 18	2.87	.77	.95	1.09	1.30	1.54	—	—	—	—	3.6
Mar. 25	3.00	.82	.92	—	1.28	1.56	—	—	—	—	3.5
Mar. 27</td											

TABLE 3.—Total, I_m , and screened, I_y , I_r , solar-radiation-intensity measurements, obtained during March 1936, and determinations of the atmospheric-turbidity factor β , and water-vapor content; w =depth in millimeters, if precipitated

AMERICAN UNIVERSITY, WASHINGTON, D. C.

Date and hour angle, 1936	Solar altitude	Air mass	I_m	I_y	I_r	$\beta_{I_{m-y}}$	$\beta_{I_{y-r}}$	β_{mean}	$\frac{I_{w=0}}{1.94}$	$\frac{I_{w=0}-I_m}{1.94}$	w	Air-mass type
									Percentage of solar constant			
Mar. 6	° '	m	gr. cal. 1.281 0.910	gr. cal. 1.283 0.910	gr. cal. 0.738 0.738	0.099	0.079	0.089	72.6	7.2	mm 7.1 7.1	Pc. 2.9 2.9
0:52 a. m.	42 04	1.49										
0:48 a. m.	42 20	1.48										

ATMOSPHERIC CONDITIONS DURING TURBIDITY MEASUREMENTS

Temperature, 7° C., wind, W. 8; visibility, 20 miles; blueness of sky, 4; polarisation, 58.9 percent.

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY

Mar. 1												
2:26 p. m.	29 57	2.00	1.067	0.740	0.633	0.117	-	0.107	0.112	62.5	8.0	5.4
Mar. 2												
4:22 a. m.	12 39	4.50	1.022	.749	.645	.047	.094	.070	51.0	10.8	5.0	Pc.
2:55 a. m.	26 42	2.22	1.239	.853	.690	.045	.065	.055	72.0	9.2	6.0	
1:20 p. m.	37 12	1.65	1.407	.945	.770	.039	.074	.056	77.4	6.1	4.3	
Mar. 4												
3:12 a. m.	23 36	2.49	1.018	.737	.588	.062	.057	.060	68.1	16.5	10.3	NPP.
2:47 a. m.	28 38	2.08	1.081	.797	.648	.109	.081	.095	62.2	6.9	4.6	
0:08 a. m.	41 10	1.52	1.152	.778	.643	.109	.162	.136	65.3	6.8	5.3	
2:30 p. m.	30 26	1.97	.998	.720	.592	.129	.135	.132	60.1	9.5	6.6	
Mar. 6												
4:15 a. m.	14 56	3.84	.884	.640	.542	.066	.087	.076	53.0	8.1	4.1	Pc.
1:38 a. m.	37 03	1.65	1.171	.818	.657	.085	.093	.094	66.3	6.9	4.1	
1:13 p. m.	39 01	1.59	1.258	.845	.670	.036	.076	.056	77.0	13.1	10.1	
3:26 p. m.	22 56	2.56	.966	.663	.490	.035	.029	.032	73.8	24.7	15.4	
Mar. 7												
4:20 a. m.	14 22	3.97	.975	.703	.598	.055	.074	.064	56.8	6.3	3.0	Pc.
Mar. 8												
4:13 a. m.	15 02	3.82	1.096	.775	.656	.029	.062	.046	60.6	4.9	3.4	Pc.
2:16 a. m.	33 33	1.81	1.346	.909	.731	.035	.056	.046	76.3	7.9	5.6	
1:22 p. m.	38 54	1.59	1.302	.855	.635	.049	.053	.051	77.8	11.7	7.3	
3:10 p. m.	26 04	2.27	.865	.612	.501	.120	.145	.132	56.2	12.2	5.4	
Mar. 10												
0:32 a. m.	43 12	1.46	1.180	.775	.610	.086	.097	.092	73.0	12.9	8.6	NPC→TA.
Mar. 13												
3:21 a. m.	25 55	2.28	1.152	.824	.660	.066	.054	.060	69.3	11.2	7.3	Pc.
2:14 a. m.	35 30	1.72	1.212	.892	.723	.138	.076	.107	68.0	8.3	5.0	
Mar. 14												
3:35 p. m.	23 58	1.78	.960	.692	.572	.175	.172	.174	62.7	13.8	7.0	Pc.
Mar. 15												
1:40 p. m.	40 12	1.55	.825	.596	.507	.148	.071	.110	63.0	20.9	13.6	NPC.
Mar. 20												
2:46 a. m.	33 25	1.81	1.189	.799	.659	.083	.078	.080	70.0	9.2	6.7	NPC.
0:00 noon	47 28	1.35	1.186	.797	.661	.110	.152	.131	73.5	12.7	9.4	
1:54 p. m.	46 53	1.37	1.089	.739	.607	.148	.194	.171	64.2	12.0	8.7	
4:17 p. m.	18 32	3.13	.926	.638	.550	.070	.118	.094	56.0	8.6	4.8	
Mar. 23												
3:30 a. m.	27 39	2.15	1.263	.854	.698	.057	.059	.058	69.7	5.1	3.3	NPC: TA aloft.
3:45 p. m.	25 08	2.35	.870	.616	.523	.133	.192	.162	50.7	6.2	2.7	
Mar. 24												
0:27 a. m.	48 05	1.34	1.222	.800	.665	.075	.075	.075	76.6	14.0	10.4	NPC.
Mar. 26												
3:19 a. m.	30 08	1.99	1.090	.750	.639	.100	.168	.134	58.6	2.7	1.2	NPC.
2:29 a. m.	37 56	1.62	1.162	.782	.654	.101	.177	.139	63.6	4.0	2.3	
0:05 a. m.	49 50	1.30	1.294	.870	.722	.115	.164	.140	70.9	4.6	3.8	
Mar. 28												
3:14 a. m.	31 34	1.90	1.307	.897	.735	.055	.075	.065	73.0	6.0	3.1	NPC.
1:53 a. m.	43 19	1.46	1.349	.911	.728	.025	.063	.044	78.2	8.9	6.0	
0:24 a. m.	50 19	1.29	1.446	.948	.760	.034	.062	.048	80.6	6.5	4.9	
Mar. 29												
4:11 a. m.	21 58	2.65	.988	.701	.585	.079	.107	.093	60.1	9.3	5.7	NPC.
2:50 a. m.	35 41	1.71	1.147	.789	.643	.101	.121	.111	66.4	7.4	5.5	
0:01 a. m.	52 01	1.27	1.230	.809	.649	.061	.123	.092	75.6	12.4	10.1	
Mar. 30												
2:34 p. m.	37 45	1.63	.796	.592	.489	.200	.200	.200	55.8	14.9	9.1	NPC.
Mar. 31												
0:35 a. m.	51 00	1.28	1.119	.749	.594	.110	.125	.122	71.3	13.6	11.7	NPC→TA.

**Atmospheric conditions during solar radiation measurements, Blue Hill Observatory
of Harvard University**
**PROVISIONAL SUNSPOT RELATIVE NUMBERS FOR
MARCH 1936**

[Dependent alone on observations at Zurich and its station at Arosa]

[Data furnished through the courtesy of Prof. W. Brunner, Eidgen. Sternwarte, Zurich,
Switzerland]

Date and time from apparent noon	Air temperature	Wind, Beaufort scale	Visibility (scale 0-10)	Sky-blueness	Cloudiness and remarks
<i>March 1936</i>					
2; 2.51 a. m.	-5.6	NE 3	6	7	1 Stcu; dense haze.
2; 1.28 p. m.	-3.9	ENE 3	8	7	Few Ci; 2 Cu; light haze.
4; 2.56 a. m.	+3.6	SSW 2	7	7	1 Ci; mod. to dense haze.
4; 0.26 a. m.	+6.3	S 4	7	7	Few Ci; Few Acu; mod. to dense haze; Acu. near sun; wind blowing in tube.
6; 2.07 a. m.	-1.9	WNW 4	8	6	Zero clouds; mod. haze.
7; 3.23 a. m.	-7.2	N 3	7	7	5 Ci; Few Stcu; light to mod. haze; thin Ci near sun.
8; 2.25 a. m.	-3.1	NW 1	8	8	Few Ci; mod. to dense haze North.
10; 0.20 a. m.	+8.5	SE 1	6	5	1 Acu; mod. haze.
13; 3.03 a. m.	+3.1	SW 6	7	8	Few Frcu; light to mod. haze; gusty wind.
15; 0.19 a. m.	+7.9	ENE 1	6	4	Zero clouds; dense haze.
15; 1.14 p. m.	+9.4	NNW 2	7	4	Zero clouds; mod. haze.
20; 0.22 a. m.	+10.8	SSW 5	7	6	1 Ci; 1 Stcu; mod. to dense water haze.
23; 3.22 a. m.	+4.4	WNW 5	10	7	Few Ci.
24; 0.17 a. m.	+9.4	ENE 3	8	7	2 Ci; few Acu; light to mod. haze.
26; 2.48 a. m.	+6.9	NW 2	6	7	Few Ci; few Frcu; dense haze.
26; 0.02 a. m.	+11.1	W 2	7	8	Few Ci; mod. haze.
28; 2.16 a. m.	+9.3	WNW 5	8	8	Few Acu; few Frcu; light to mod. haze; wind gusty.
28; 0.24 a. m.	+10.9	WNW 5	8	8	Few Acu; few Cu; light haze; wind gusty.
29; 3.08 a. m.	+8.2	W 4	8	6	Zero clouds; light to mod. haze.
29; 0.20 a. m.	+13.2	WSW 5	8	7	Zero clouds; light to mod. haze.
30; 3.24 p. m.	+17.7	E 2	7	7	1 Ci; mod. to heavy haze.

March 1936	Relative numbers	March 1936	Relative numbers	March 1936	Relative numbers
1	a 74	11	79	21	104
2	68	12	a 67	22	96
3	a 60	13	Ec 59	23	82
4	a 55	14	68	24	53
5	Mc ..	15	56	25	Ec 49
6	a 60	16	a 61	26	ad ..
7	Mc 83	17	60	27	d ..
8	89	18	Mc 66	28	Mc 98
9	Ec 88	19	Macd 87	29	98
10	ad 92	20	112	30	Eac 103

Mean, 28 days = 77.7

a=Passage of an average-sized group through the central meridian.

b=Passage of a large group or spot through the central meridian.

c>New formation of a center of activity: E, on the eastern part of the sun's disk; W, on the western part; M, in the central circle zone.

d=Entrance of a large or average-sized center of activity on the east limb.

POSITIONS AND AREAS OF SUN SPOTS

NOTE.—The reports for March, not having been received, will be included with those for April in the next issue.

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE, in charge]

By L. T. SAMUELS

At those stations with a sufficient period of record for the determination of approximate normals, upper-air temperatures during March averaged above normal except on the Pacific Coast, where the departures were negative (see table 1). In practically all cases the departures were of moderate magnitude. Mean temperatures for the month were slightly lower over the central and north-central part of the country than over corresponding latitudes in the eastern and western sections.

Upper-air relative humidity departures were, in general, of opposite sign to those for temperature. Mean upper-air relative humidities for the month were strikingly low over Maxwell Field and Pensacola as compared to the other stations.

The directions of the upper-air wind resultants were close to normal in most cases (see table 2). Resultant velocities exceeded the normals over most of the northern stations, and were mostly below normal elsewhere. Departures were in general of small magnitude.

TABLE 1.—Mean free-air temperatures and relative humidities obtained by airplanes during March 1936

TEMPERATURE (° C.)

Stations	Altitude (meters) m. s. l.												Number of observations						
	Surface		500		1,000		1,500		2,000		2,500		3,000		4,000		5,000		
	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	Mean	Departure from normal	
Barksdale Field (Shreveport), La. ¹ (52 m.)	12.8		15.4		13.6		11.0		8.2		5.5		2.8		-3.0		-10.0		30
Billings, Mont. ² (1,088 m.)	-0.9						-1.0		-3.8		-7.5		-11.1		-17.9		-24.5		31
Cheyenne, Wyo. ² (1,873 m.)	-2.4								-1.9		-2.4		-5.2		-12.1		-19.1		29
El Paso, Tex. ² (1,194 m.)	10.2						11.6		9.0		5.4		1.8		-5.3		-11.5		31
Fargo, N. Dak. ² (274 m.)	-6.1		-5.2		-5.4		-6.8		-8.7		-10.6		-13.1		-18.8		-25.9		29
Kelly Field (San Antonio), Tex. ¹ (208 m.)	12.3		16.2		14.8		13.1		10.9		8.1		4.9		-1.9		-9.3		30
Lakehurst, N. J. ³ (39 m.)	4.8		6.0		4.2		2.3		0.1		-2.4		-5.0		-11.6		-21.3		26
Maxwell Field (Montgomery), Ala. ¹ (52 m.)	10.7		13.1		10.6		7.0		5.0		2.8		+0.3		-5.5		-13.0		24
Mitchel Field (Hempstead, Long Island), N. Y. ¹ (29 m.)	4.4		5.4		3.6		1.5		-0.3		-2.8		-5.8		-12.6		-21.6		21
Murfreesboro, Tenn. ² (174 m.)	7.5		10.2		8.5		6.0		3.3		0.6		-2.2		-8.4		-14.9		31
Norfolk, Va. ² (10 m.)	9.9	+2.6	12.1	+5.2	9.6	+4.7	6.4	+3.8	3.9	+3.5	1.2	+2.9	-1.6	+2.4	-8.1	+1.8	-14.0	+1.8	17
Oklahoma City, Okla. ² (391 m.)	10.3		11.6		11.7		9.7		6.9		4.1		1.0		-5.9		-12.9		26
Omaha, Nebr. ² (300 m.)	1.7	+1.9	2.8	+2.3	3.3	+2.3	2.3	+2.0	0.3	+1.5	-2.3	+1.3	-5.5	+1.0	-12.3	+0.7	-19.2	+0.6	31
Pearl Harbor, Territory of Hawaii ³ (6 m.)	20.2	-2.3	18.9	-1.0	15.3	-0.9	12.2	-1.2	10.4	-0.7	9.2	-0.2	6.1	-1.1	-0.5	-2.3	-1.4	31	
Pensacola, Fla. ² (2 m.)	14.0	+1.7	14.5	+2.7	12.5	+2.5	10.6	+2.5	8.2	+2.1	5.6	+1.6	3.3	+1.5	-2.6	+1.4	-9.4	+1.2	28
San Diego, Calif. ² (10 m.)	12.3	-1.7	12.2	-0.7	11.9	-0.3	10.3	+0.1	7.6	-0.3	4.5	-0.7	1.3	-1.0	-4.2	-0.2	-10.1	+0.5	30
Scott Field (Bellville, Ill.) ¹ (135 m.)	4.3		6.5		6.2		4.7		2.3		-0.4		-3.3		-9.1		-15.1		31
Seattle, Wash. ² (10 m.)	6.4	-2.4	2.5	-3.3	-0.5	-3.3	-2.8	-2.8	-6.4	-3.4	-10.0	-4.1	-13.3	-4.6	-18.0	-3.6	-25.0	-3.8	8
Spokane, Wash. ² (598 m.)	0.8						0.4		-2.7		-5.9		-9.4		-16.5		-23.7		31
Washington, D. C. ² (13 m.)	6.2	+0.8	8.1	+3.8	6.1	+3.7	3.7	+3.4	1.3	+3.1	-1.1	+2.8	-4.2	+1.9	-10.0	+1.8	-15.8	+2.0	23
Wright Field (Dayton), Ohio ¹ (244 m.)	3.4		4.4		4.2		2.6		0.5		-1.8		-4.1		-10.0		-17.1		30